

HERPETOLOGY.—*Studies on the lizard family Xantusiidae, II: Geographical variation in Xantusia riversiana from the Channel Islands of California.* JAY M. SAVAGE, Natural History Museum, Stanford University. (Communicated by F. J. Hermann.)

While studying the Baja California night lizards of the species *Xantusia vigilis* (Savage, 1951), I examined the two supposed subspecies of the island night lizard, *Xantusia riversiana*, in an attempt to determine what characters might be of value in delimiting subspecies within the genus. Preliminary inspection revealed that the characters used to differentiate the two nominal subspecies of *riversiana* were apparently so subject to individual variation and personal interpretation that doubt was cast upon the value of sub-dividing the species.

Xantusia riversiana was described by Cope (1883, p. 29) as the second known species of the genus. Since that time the species has been found to be endemic to San Nicolas, Santa Barbara, and San Clemente Islands in the southern group of Channel Islands off the coast of southern California. The restricted range and structural homogeneity of the island night lizards has caused most authors to regard all three insular colonies as forming a single population. Dr. Hobart M. Smith (1946, p. 292) was the first seriously to question this concept. He proposed that the San Clemente Island colony should be recognized as a distinct subspecies, *X. riversiana reticulata*. His conclusions were derived from an examination of one specimen from San Clemente Island and three examples from San Nicolas Island, the type locality of *X. r. riversiana*.

Smith would differentiate the two nominal subspecies on the basis of the following characteristics: *riversiana*—(1) preanal scales large, regular; (2) central gular scales somewhat enlarged; (3) preangular fold well defined; (4) sutures between head scales clearly apparent, although some pits present; (5) a distinct dorsolateral light streak on each side; (6) dorsal pattern less distinctly marked with dark; *reticulata*—(1) preanal scales small, irregular; (2) central gular scales nearly uniform, scarcely enlarged medially; (3) preangular fold poorly defined; (4) head plates exceedingly pitted, corrugated and

broken up; (5) no dorsolateral light line; (6) dorsal pattern reticulated and spotted with black.

ANALYSIS OF CHARACTERISTICS

The taxonomic value of several of these characteristics (size of gulars, nature of preangular fold, and coloration) might immediately be questioned by anyone familiar with variation in xantusiid lizards. Others of the supposed diagnostic characters would at first glance seem to be useful in the definition of subspecies in this family (size and number of preanals and nature of head scalation). In order to discover the normal range of variation and determine those differences of systematic significance, an analysis of each of Smith's criteria was undertaken in a relatively large sample of island night lizards. Comparison and study of 24 specimens from San Nicolas Island, 11 from Santa Barbara Island, and 61 from San Clemente Island have supplied the information presented below and represent, I believe, an adequate summary of the variation of these characteristics.

Prenals.—The preanal scales are basically six in number, large and arranged in three transverse rows. Considerable breaking up of these scales occurs in some individuals, and the condition may vary from the regular 6-scaled type through innumerable intermediates until as many as 18 small, irregular scales are present. The majority of specimens in this sample had seven to nine preanal scales. Fisher (1936, p. 175) illustrates a similar variability in a large sample of the mainland species, *X. vigilis vigilis*.

Obviously, when applying Smith's terms "large, regular" and "small, irregular" to this character, it was necessary to set rather arbitrary limits as to what constituted these two categories. When the preanals were maintained in a condition approaching a regular series of large, unbroken scales they have been recorded as "large." Those lizards with the preanal scales fragmented into a large number of small, irregularly shaped scales have been included under "small." Utilizing these definitions the nature of the preanal scales and the percentage composition of each type in the three insular populations is given in Table 1.

TABLE 1.—VARIATION IN PREANAL SCALES

	San Nicolas		Santa Barbara		San Clemente		Totals	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Large, regular	8	33	1	9	20	33	29	30
Small, irregular	16	67	10	91	41	67	67	70
Totals	24	100	11	100	61	100	96	100

An examination of Table 1 shows that the presence of "large" preanal scales is consistently low in all three island populations. San Clemente and San Nicolas Island specimens are almost identical in the percentage composition of large and small preanals and cannot be separated on the basis of this character. No significant difference exists between these two samples and the series from Santa Barbara Island. The apparent discrepancy in the percentage composition between this latter group of lizards and those from the other two islands is probably attributable to the small size of the Santa Barbara sample.

Actually the splitting up of the preanal scales is probably not the result of any genetic factor but of a developmental change produced by some environmental influence during early ontogeny. Similar environmental effects have been shown to influence scutellation in snakes (Fox, 1948, p. 252) and in turtles (Lynn and Ullrich, 1950, p. 253). If environmental factors are responsible, the slight differences observed between Santa Barbara Island lizards and the series from other islands could not be considered of systematic value as a significant difference would only be a reflection of ecological effects upon the development of the sample. Obviously the nature of the preanal scales in island night lizards is of no taxonomic value and cannot be accepted as a criterion for distinguishing subspecies.

Gular scales.—The difference in the relative size of the median gular scales, as used by Smith, is of such a fine qualitative distinction as to be almost impossible to apply. As pointed out by Fisher (1936, p. 174) in the related night lizard, *X. v. vigilis*, the number of enlarged scales on the gular fold is subject to wide variation. In *X. riversiana* the size of the gulars as well as the number is quite variable. It is true that some individuals appear to have the two median gular scales somewhat larger than their fellows but just where to draw the line between gulars

"scarcely enlarged medially" and gulars that are "somewhat enlarged" presents a problem. It was necessary for tabulation that some sort of decision as to what constitutes these two categories be made. I have therefore included under the "enlarged" group only those examples having the central gular scales very definitely larger than those adjacent to them. Frankly, I do not feel that even this method is valid in determining the size of the gulars, and independent examination of several series at different times confirms this suspicion. A sample of specimens from each island was examined by me on four different occasions. Upon each one of these occasions a different number of "enlarged" examples was recognized. To make matters worse, examples classified as "large" on one occasion would be grouped with "scarcely enlarged" the next time the samples were examined. Apparently the character is so variable that a clear-cut decision cannot be made as to which group, "enlarged" or "scarcely enlarged," any given individual belongs.

The results of the analysis of this characteristic, utilizing the methods of determination explained above, are presented in Table 2. San Clemente lizards are almost constant in having the median scales enlarged. The small Santa Barbara series has more enlarged than uniform examples and the San Nicolas specimens are almost evenly divided between the two types. It might be argued that the San Clemente Island population could be separated from the other two colonies on the basis of this character. However, at least 50 percent of the San Nicolas and Santa Barbara specimens would fall into the same category as San Clemente examples. The high percentage of "enlarged" gulars listed for the San Clemente sample may actually be the result of bias on my part. These specimens were the first lizards examined in the study when I was not too adept at distinguishing between the two supposed types of gulars. Consequently it is probable that a re-

TABLE 2.—VARIATION IN SIZE OF GULAR SCALES

	San Nicolas		Santa Barbara		San Clemente		Totals	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Enlarged	14	58	9	82	60	98	83	86
Uniform	10	42	2	18	1	2	13	14
Totals	24	100	11	100	61	100	96	100

examination of the San Clemente series would result in slightly different groupings. These facts coupled with the difficulties already emphasized in determining the nature of the gular scale character forces the rejection of this characteristic as a systematic aid.

Pregular fold.—All *Xantusia* possess two more or less well-developed preular folds. The posterior fold is usually well marked and lies only a few scales anterior to the gular fold. The anterior preular fold extends from the base of the auricular aperture on one side across the throat to the opposite ear opening and is usually poorly developed or absent in the live animal. It is this latter fold which is used by Smith to characterize his two subspecies of *X. riversiana*. Unfortunately, Smith did not have enough material to ascertain that the anterior preular fold is often absent in living material and usually appears only as the result of preservation. In my experience, the anterior preular fold is often distorted and frequently not visible even subsequent to preservation. Consequently, the separation of two populations on the basis of the presence or absence of this fold seems impossible.

Table 3 represents the presence or absence of the anterior preular fold in a series of unevenly preserved specimens. The table is nothing but an account of the manner in which these lizards were preserved and is included to make it obvious that even if this character were not due to the mode of preservation no really significant differences occur between the various colonies. The San Nicolas sample is somewhat isolated in the relative proportions of the two types of fold but this is probably the result of the fact that the majority of the San Nicolas examples are from a single collection and were all preserved in a similar manner. The preular difference is thus of absolutely no significance in *X. riversiana*.

Pitting of the head shields.—Table 4 shows that the number of individuals from each sample with the head shields so pitted as to completely obscure the sutures between the shields is relatively small. The character appears to be correlated with the age of the specimen, for the head shields are broken up in all large examples regardless of locality and the smaller specimens lack excessive pittings. The pits are present on all lizards examined although difficult to find on a number of small examples. They appear to be the openings of integumentary "glands" similar in some respects to the femoral pores. Apparently these

TABLE 3.—VARIATION IN PREGULAR FOLD

	San Nicolas		Santa Barbara		San Clemente		Totals	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Well defined	9	37	7	64	47	77	63	66
Poorly defined	15	63	4	36	14	23	33	34
Totals	24	100	11	100	61	100	96	100

TABLE 4.—VARIATION IN STRUCTURE OF HEAD SHIELDS

	San Nicolas		Santa Barbara		San Clemente		Totals	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Broken up	0	0	2	18	6	10	8	8
Smooth	24	100	9	82	55	90	88	92
Totals	24	100	11	100	61	100	96	100

pits grow at a constant rate throughout life and, after the general growth rate of the lizard begins to slow down at maturity, the pits continue to expand and eventually succeed in completely deforming the usual configuration of the head shields. No geographic correlation of a sufficient magnitude to warrant a separation of one insular colony from another is indicated by the distribution of this character. San Nicolas Island examples lack broken up head shields but this is probably the fault of the sample which consists almost entirely of moderate-sized lizards. This character must also be rejected as a means of delimiting subpopulations of *X. riversiana*.

Dorsal coloration.—The dorsal pattern of these lizards is usually a gray, brownish or cream ground-color upon which is superimposed a series of reticulated longitudinal bands. These bands vary in color from light brown to black and are sometimes coalesced to form two rigidly delimited dorsolateral dark stripes and a single well-defined dorsal band. The ground color between these stripes or bands appears as two light spaces. In extreme specimens possessing these dorsolateral light stripes the upper margins of the dark dorsolateral stripes and lower margins of the middorsal stripe are heavily pigmented so that the light interspace is sharply defined. This is the condition assumed by Smith to be typical of San Nicolas Island night lizards. All sorts of

intermediates between the reticulate pattern and the lined phase occur within any single population. All young examples tend to be more or less striped in appearance but the most prominently striped specimens are mature individuals.

Taking the lizards with light lines well defined and bordered by a dark stripe as being "lined" and all other lizards as being "unlined," I prepared Table 5. The complete absence of striped individuals in the Santa Barbara series is most likely due to the small sample size. San Nicolas Island and San Clemente Island colonies are close in relative percentage composition of the two color phases. The character is obviously worthless as a means of separating the various island populations. It may be that the extreme lined phase is the product of a single recessive allele although the observed frequencies of lined forms are somewhat lower than might be expected on the basis of such a hypothesis.

It is notable that Dr. George S. Myers, of Stanford University, reports that he took both lined and unlined phases side by side under the same debris on San Clemente Island. Kenneth S. Norris, of the Scripps Institution of Oceanography, informs me of the same condition occurring on San Nicolas Island.

Other characters.—An analysis of scale counts and measurements reveals no significant differences between the three insular populations. Data on these counts and a complete redescription of the island night lizard are reserved for a projected monograph of the Xantusiidae.

TABLE 5.—VARIATION IN OCCURRENCE OF DORSOLATERAL LIGHT LINES

	San Nicolas		Santa Barbara		San Clemente		Totals	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Lined	5	21	0	0	6	10	11	11
No lines	19	79	11	100	55	90	85	89
Totals	24	100	11	100	61	100	96	100

CONCLUSIONS

None of the characteristics employed by Smith to define his subspecies of *X. riversiana* are of value in separating the various island colonies. One character (preanals) is perhaps the result of environmental effects, another (gular scales) is a matter of individual interpretation, a third (pregular fold)

reflects the mode of preservation, a fourth (pitting of the head shields) is probably ontogenetic in nature, and the last (dorsal coloration) appears to be due to normal genetic variation. Since none of these characteristics can be utilized in defining subpopulations of the island night lizard, it follows that the name *X. riversiana reticulata* must be relegated to the synonymy of *X. riversiana*. This action is taken in the hope that it will avert further use of the name in the literature (Schwenkmeyer, 1949; Shaw, 1949; Knowlton, 1949) and prevent the recognition of a systematically nonexistent entity.

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